

## Microbial Ecosystem Structure

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The Ames Geobiology and Ecosystem Structure Laboratory is a new facility established in FY00. The research goals of this laboratory are to contribute to our understanding of the spatial distribution of microbes in biofilms, microbial mats, and stromatolites, and to understand how these distribution patterns are recorded in the rock record. Spatial distribution of microbes is of critical importance in facilitating the transfer of gaseous and dissolved compounds between both microorganisms and microorganisms and their environment. Because microorganisms are motile and can in effect position themselves where conditions are most advantageous, their distribution patterns offer key clues as to how these ecosystems function. The old adage is that "everything is everywhere, but the milieu selects." Understanding how microbes react to the milieu via their physical distribution is, therefore, key to interpreting modern, ancient, and extraterrestrial microbial ecosystems.

However, most microbial ecology research approaches are not designed to address this issue. Microbes cultivated as single-organism populations in a test tube will not behave in the same manner as those in mixed microbial population assemblages in natural environments. In natural environments, microbial populations experience fluctuations in irradiance, water flow, and chemical environment that are seldom, if ever, seen in a laboratory environment. Monitoring of natural ecosystems offers clues as to how ecosystems function, but the large number of variables operating at any given time prohibit rigorous scientific manipulation and testing. The goal is to bridge this gap by conducting controlled, mixed microbial ecosystem experimentation.

The first series of experiments in the Geobiology and Ecosystem Structure Laboratory has documented that given an initial, homogeneous distribution, within carbonate sediments, four different cyanobacterial isolates will repeatedly segregate themselves with distinctly different distribution patterns. However, the actual distribution patterns observed are a function of speed of water flow, permeability of sediments, availability of nutrients, and irradiance conditions. Hence it is possible to control the degree and pattern of lamination that occurs in these sediments. The cyanobacteria used in these experiments are cultures isolated from modern stromatolites. This approach provides a powerful tool for interpreting the distribution patterns of these cyanobacteria in their natural environment, which to a great extent causes the formation of the laminated fabric of actively lithifying stromatolites. Some of these microbes act as binding agents that hold sediments together, while others are active agents in the precipitation of new mineral components that convert the biological ecosystem into a lithified structure that can be preserved in the rock record. Understanding the controls of formation of these laminated fabrics in modern stromatolites is a first step in improving the interpretation of lamination biosignatures in ancient stromatolites from Earth and potentially laminated rocks from extraterrestrial sources.

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